DISK PLAYBACK DEVICE

TECHNICAL FIELD

5   The present invention relates to disk playback devices for reproducing signals from a disk by irradiating the disk with a laser beam from an optical head.

BACKGROUND ART

10   For use as recording media in disk recording-playback devices, magneto-optical disks have been developed which permit rewriting and have a great memory capacity and high reliability. Such disks have found wide use as external memories in computers and audio visual devices.

15   Developed especially in recent years are techniques for achieving improved recording densities by forming lands 11 and grooves 12 alternately on a signal bearing surface of a magneto-optical disk 1 as shown in FIG. 12 and recording signals on both the lands 11 and the grooves 12. The lands

20   11 and the grooves 12 are wobbled as illustrated, and the wobbling frequency is a predetermined center frequency as frequency-modulated. A wobble signal is detected by signal reproduction, and the rotation of the magneto-optical disk is so adjusted that the wobble signal has the center frequency

at all times, whereby constant linear velocity control is realized. Various items of information (wobble information) such as address information are contained in the wobble signal which is frequency-modulated as stated above. Various

5 control operations are realized based on the wobble information at the time of signal reproduction.

When disk recording-playback devices are in operation for reproducing or recording signals, focus servo or tracking servo is performed for the actuator incorporated in the

10 optical head, based on focus error (FE) signals and tracking error (TE) signals. When the disk recording-playback device is initiated into operation, an offset adjustment is made for focusing or tracking based on the TE signals and RF signals to thereby effect accurate focus servo and tracking servo.

15 In a process for determining an optimum offset value for a focus error based on the TE signal, as seen in FIG. 19, first, focus offset values are respectively set at at least five different values P_0 to P_4 centered about an initial value P_0, and amplitude values of the TE signal at the respective

20 offset values are measured. Among said at least five points measured, a first point is set at a point having the maximum amplitude value, a second point is set at a point having an offset value smaller than the offset value P_0 at the first point and an amplitude value not greater than a value (T_0 –

5) obtained by subtracting a predetermined value from an amplitude value T_0 at the first point, a third point is set at a point having an offset value greater than the offset value P_0 at the first point and an amplitude value not

5   greater than the value $(T_0 - 5)$ obtained by subtracting the predetermined value from the amplitude value T_0 at the first point. With reference to the offset values P_0, P_1, P_4 and the amplitude values T_0, T_1, T_4 at the respective three points, a quadratic curve representing the relationship between the

10   offset values and the amplitude values is determined. An offset value corresponding to the peak of the quadratic curve is determined as an optimum offset value P_{opt1}. A procedure for determining an optimum offset value based on the RF signals is the same as the above.

15   FIGS. 13 to 15 show a focus offset adjustment procedure to be executed based on the TE signals when the disk recording-playback device is into an initiation operation. First in steps S91 to S94 in FIG.13, focus offset values are respectively set at an initial value P_0, a value P_1 smaller

20   than the initial value by eight steps, a value P_2 smaller than the initial value by four steps, a value P_3 greater than the initial value by four steps, and a value P_4 greater than the initial value by eight steps, and amplitude values T_0 to T_4 are measured at the respective offset values. Among these

five points measured, thereafter, a first point is set at a

point having the maximum amplitude value. A first offset

value P_{max} is set at an offset value at the first point. A

first amplitude value T_{max} is set at an amplitude value at the

5 first point.

Subsequently in step S95, an inquiry is made as to

whether a second point having an offset value P_x smaller than

the first offset value P_{max} and an amplitude value T_x smaller

than the first amplitude value T_{max} by five steps or more is

10 included in four measured points other than the first point.

If the inquiry is answered in the affirmative, step S96

follows to set a second offset value P_A at the offset value P_x

at the second point, set a second amplitude value T_A at the

amplitude value T_x at the second point, and set to "TRUE" a

15 P_A_flag indicating whether the second offset value P_A is

obtained, thereafter followed by step S97.

In step S97, an inquiry is made as to whether a third

point having an offset value P_x greater than the first offset

value P_{max} and an amplitude value T_x smaller than the first

20 amplitude value T_{max} by five steps or more is included in the

four measured points other than the first point. If the

inquiry is answered in the affirmative, step S98 follows to

set a third offset value P_B at the offset value P_x at the

third point, set a third amplitude value T_B at the amplitude

value T_x at the third point, and set to "TRUE" a P_B_flag indicating whether the third offset value P_B is obtained, thereafter followed by step S99 shown in FIG. 14.

When the second point and the third point are both included in the four measured points other than the first point, answers to inquiries in step S99 in FIG. 14 and in step S106 in FIG. 15 are affirmative, followed by step S113. With reference to data on the first to third points (P_{max}, T_{max}), (P_A, T_A) and (P_B, T_B) which are included in the five measured points, the relationship between the offset values and the amplitude values is approximated to a quadratic curve, and an offset value corresponding to the peak of the quadratic curve is calculated as an optimum offset value P_{opt}, to terminate the procedure.

On the other hand, when the second point is not included in the four measured points other than the first point, an answer to the inquiry in step S99 in FIG. 14 is negative. In steps S100 to S105, an offset value P is decreased every four step starting from a value smaller than the initial value P_0 by 12 steps, to thereby vary the offset value until when the amplitude value T becomes a value smaller than the first amplitude value T_{max} by five steps or more. Then the offset value and amplitude value concerned are respectively set at a second offset value P_A and a second amplitude value T_A.

Accordingly the second point is retrieved. When, in step

S113 in FIG. 15, the relationship between the offset values

and the amplitude values is approximated to a quadratic curve,

the data (P_A, T_A) at the retrieved second point is used.

5   Incidentally, in retrieving the second point, in the case

where the offset value P is smaller than the initial value P_0

by 20 steps or more to make the answer to step S101

affirmative, or in the case where the amplitude value T is

not greater than a lower limit value T_L to make the answer to

10   step S103 affirmative, focus servo deviates to terminate the

procedure.

Furthermore, when the third point is not included in the

four measured points other than the first point, an answer to

the inquiry in step S106 in FIG. 15 is negative. In steps

15   S107 to S112, an offset value P is increased every four step

starting from a value greater than the initial value P_0 by 12

steps, to thereby vary the offset value until when the

amplitude value T becomes a value smaller than the first

amplitude value T_{max} by five steps or more. Then the offset

20   value and amplitude value concerned are respectively set at a

third offset value P_B and a third amplitude value T_B.

Accordingly the third point is retrieved. When, in step S113,

the relationship between the offset values and the amplitude

values is approximated to a quadratic curve, the data (P_B, T_B)

at the retrieved third point is used. Incidentally, in retrieving the third point, in the case where the offset value P is greater than the initial value P_0 by 20 steps or more to make the answer to step S108 affirmative, or in the

5 case where the amplitude value T is not greater than a lower limit value T_L to make the answer to step S110 affirmative, focus servo deviates to terminate the procedure.

According to the above procedure, the optimum offset value P_{opt} for the focus error is determined based on the TE

10 signals, and an offset adjustment for focusing is made based on the optimum offset value P_{opt}. According to the same procedure, an optimum offset value for the focus error is determined based on the RF signals, and an offset adjustment for focusing is made based on the optimum offset value. The

15 disk recording-playback device starts signal reproduction or signal recording after the offset adjustment for focusing thus made.

In a usual operation for signal reproduction or signal recording, variations in the ambient temperature, however,

20 lead to the distortion of the housing or parts of the optical head, a shift of position of the optical sensor, variations in the laser wavelength, etc., altering the offset value from an optimum value and consequently impairing the accuracy of focus servo. If the offset value deviates from the optimum

value greatly, the bit error rate of reproduced signal

exceeds a prescribed value, presenting difficulty in

effecting normal reproduction and recording.

In the usual operation, an offset adjustment for

5 focusing is made every time a temperature of the disk varies

by a predetermined temperature or more.

In a process of determining an optimum offset value for

a focus error based on the TE signals for the usual operation,

as seen in FIG. 20, first, focus offset values are

10 respectively set at at least five different values P_{opt1}, P_1'

to P_4', centered about the optimum offset value P_{opt1}, i.e.,

the set value concerned, determined in a previous offset

adjustment processing, and amplitude values of the TE signals

at the respective offset values are measured. Among said at

15 least five points measured, a first point is set at a point

having the maximum amplitude value, a second point is set at

a point having an offset value smaller than the offset value

P_{opt1} at the first point and an amplitude value not greater

than a value (T_{opt1} - 5) obtained by subtracting a

20 predetermined value from an amplitude value T_{opt1} at the first

point, a third point is set at a point having an offset value

greater than the offset value P_{opt1} at the first point and an

amplitude value not greater than the value (T_{opt1} - 5)

obtained by subtracting the predetermined value from the

amplitude value T_{opt1} at the first point. With reference to the offset values P_{opt1}, P_1', P_4' and the amplitude values T_{opt1}, T_1', T_4' at the respective three points, a quadratic curve representing the relationship between the offset values and

5 the amplitude values is determined. An offset value corresponding to the peak of the quadratic curve is determined as an optimum offset value P_{opt2}. A procedure of determining an optimum offset value based on the RF signals is the same as the above.

10 FIGS. 16 to 18 show a focus offset adjustment procedure to be executed based on the TE signals when temperature variations in excess of or equal to a predetermined value (= 5 °C) occur in a usual operation after the system's initiation into operation. First in steps S121 to S124,

15 focus offset values are respectively set at a set value concerned P_0', a value P_1' smaller than the set value by eight steps, a value P_2' smaller than the set value by four steps, a value P_3' greater than the set value by four steps, and a value P_4' greater than the set value by eight steps, and

20 amplitude values T_0' to T_4' are measured at the respective offset values. Among these five points measured, thereafter, the maximum amplitude value is a first point. An offset value at the first point is a first offset value P_{max}'. An amplitude value at the first point is a first amplitude value

T_{max}'.

Subsequently in step S125, an inquiry is made as to whether a second point having an offset value P_x' smaller than the first offset value P_{max}' and an amplitude value T_x'

5   smaller than the first amplitude value T_{max}' by five steps or more is included in four measured points other than the first point. If the inquiry is answered in the affirmative, step S126 follows to set a second offset value P_A at the offset value P_x' at the second point, set a second amplitude value T_A

10 at the amplitude value T_x' at the second point, and set to "TRUE" a P_A_flag indicating whether the second offset value P_A is obtained, thereafter followed by step S127.

In step S127, an inquiry is made as to whether a third point having an offset value P_x' greater than the first

15 offset value P_{max}' and an amplitude value T_x' smaller than the first amplitude value T_{max}' by five steps or more is included in the four measured points other than the first point. If the inquiry is answered in the affirmative, step S128 follows to set a third offset value P_B at the offset value P_x' at the

20 third point, set a third amplitude value T_B at the amplitude value T_x' at the third point, and set to "TRUE" a P_B_flag indicating whether the third offset value P_B is obtained, thereafter followed by step S129 shown in FIG. 17.

When the second point and the third point are included

in the four measured points other than the first point, answers to inquiries in step S129 in FIG. 17 and in step S136 in FIG. 18 are affirmative, followed by step S143. With reference to data on the first to third points (P_{max}', T_{max}'),

5 (P_A, T_A) and (P_B, T_B) which are included in the five measured points, the relationship between the offset values and the amplitude values is approximated to a quadratic curve, and an offset value corresponding to the peak of the quadratic curve is calculated as an optimum offset value P_{opt}', to terminate

10 the procedure.

On the other hand, when the second point is not included in the four measured points other than the first point, a second point is retrieved according to the same procedure as that in an initiation operation as shown in steps S130 to

15 S135 in FIG. 17. When, in step S143 in FIG. 18, the relationship between the offset values and the amplitude values is approximated to a quadratic curve, data (P_A, T_A) at the retrieved second point is used.

Furthermore, when the third point is not included in the

20 four measured points other than the first point, a third point is retrieved according to the same procedure as that in an initiation operation as shown in steps S137 to S142 in FIG. 18. When, in step S143, the relationship between the offset values and the amplitude values is approximated to a

quadratic curve, data (P_B, T_B) at the retrieved third point is used.

According to the above procedure, the optimum offset value P_{opt}' for a focus error is determined based on the TE signals, and the focus offset adjustment is made based on the optimum offset value P_{opt}'. According to the same procedure, an optimum offset value for a focus error is determined based on the RF signals, and the focus offset adjustment is made based on the optimum offset value. The disk recording-playback device starts signal reproduction or signal recording after the offset adjustment for focusing thus made. When the disk recording-playback device is in the usual operation, the focus offset adjustment is thus made, consequently effecting focus servo with high accuracy at all times despite variations in temperature of the magneto-optical disk.

However, the disk recording-playback device described has the following problem: in the offset adjustment procedure of the usual operation, the relationship between the offset values and the amplitude values is approximated to a quadratic curve with reference to the previous optimum offset value P_{opt1}, and the second and third offset values P_1', P_4' each having an amplitude value smaller than the amplitude value T_{opt1} at the offset value P_{opt1} by a predetermined value

or more, as shown in FIG. 20, to increase accuracy of the
quadratic curve. For obtaining the second and third offset
values P_1', P_4', amplitude values at at least five different
offset values P_{opt1} and P_1' to P_4' need be measured, requiring

5   a long period of time for determining the quadratic curve,
thereby entailing the problem of a long period of time taken
for the calculation of the optimum offset value.

An object of the present invention is to provide a disk
playback device which is adapted to determine the optimum

10 offset value for the error signal in a short period of time
when in the usual operation.

DISCLOSURE OF THE INVENTION

The present invention provides a disk playback device

15 comprising a calculation processing circuit for determining
an optimum value of offset for an error signal based on an
amplitude value of the error signal in accordance with focus
deviation or tracking deviation of an optical head, or an
amplitude value of an output signal of the optical head, and

20 making an offset adjustment based on the optimum offset value.
The calculation processing circuit approximates to a
quadratic curve the relationship between offset values and
the amplitude values in signal reproduction, and repeats
calculation of the optimum offset values based on the

quadratic curve. The calculation processing circuit
comprises:

calculation processing means for approximating to a
quadratic curve the relationship between the offset values

5   and the amplitude values with reference to three different
offset values and three amplitude values at the respective
offset values, and calculating an offset value corresponding
to the peak of the quadratic curve as the optimum offset
value, and

10   value setting means for setting the three different
offset values: a first offset value; a second offset value
smaller than the first offset value and having an amplitude
value smaller than an amplitude value at the first offset
value by a predetermined value or more; a third offset value

15   greater than the first offset value and having an amplitude
value smaller than an amplitude value at the first offset
value by a predetermined value or more, and setting the three
amplitude values respectively at three amplitude values at
the first to third offset values. The value setting means

20   sets the first offset value at an optimum offset value
obtained in a previous optimum offset value calculation
processing, and sets the second and third offset values
respectively at second and third offset values set in a
previous optimum offset value calculation processing.

According to an optimum offset value calculation processing in a usual reproduction operation of the present invention, the first offset value is set at an optimum offset value obtained in a previous optimum offset value calculation

5 processing, and the second and third offset values are respectively set at second and third offset values set in a previous optimum offset value calculation processing.

Incidentally, the second and third offset values set in the previous optimum offset value calculation processing each

10 has an amplitude value smaller than an amplitude value at the first offset value by a predetermined value or more. Further, the offset value corresponding to the peak of the quadratic curve is calculated as the optimum offset value, so that the optimum offset value obtained in the previous optimum offset

15 value calculation processing has an amplitude value greater than the amplitude value at the first offset value. Accordingly, the second and the third offset values each has an amplitude value smaller than the amplitude value at the optimum offset value by a predetermined value or more.

20 Furthermore, when the disk playback device is in a usual reproduction operation, the quadratic curve representing the relationship between the offset values and the amplitude values shows little change. Therefore, also in the current offset value calculation processing, the amplitude values at

the previous second and third offset values have a very high

possibility of being smaller than the amplitude value at the

previous optimum offset value by a predetermined value or

more, whereby the quadratic curve can be determined with high

5   accuracy with reference to the previous optimum offset value,

the second and third offset values, and the amplitude values

at the respective offset values.

According to the optimum offset value calculation

processing of the present invention, if the amplitude values

10   at at least three offset values, i.e., the previous optimum

offset value, the previous second and third offset values,

are measured, the quadratic curve can be determined with high

accuracy with reference to these three offset values and

three amplitude values. Thus a period of time required for

15   the determination of the quadratic curve is made shorter than

conventionally, because, with the conventional device, the

measurement of amplitude values at at least five different

offset values is required. This makes shorter a period of

time taken for the calculation of the optimum offset value.

20   Stated specifically, the calculation processing circuit

comprises:

first checking means for checking whether an amplitude

value at the previous second offset value is smaller than an

amplitude value at the previous optimum offset value by a

predetermined value or more,

second checking means for checking whether an amplitude value at the previous third offset value is smaller than an amplitude value at the previous optimum offset value by a predetermined value or more, the value setting means comprising:

second offset value setting means for retrieving an offset value having an amplitude value smaller than the amplitude value at the previous optimum offset value by a predetermined value or more when the amplitude value at the previous second offset value is not found to be smaller than the amplitude value at the previous optimum offset value by a predetermined value or more, and setting a second offset value at the retrieved offset value, and

third offset value setting means for retrieving an offset value having an amplitude value smaller than the amplitude value at the previous optimum offset value by a predetermined value or more when the amplitude value at the previous third offset value is not found to be smaller than the amplitude value at the previous optimum offset value by a predetermined value or more, and setting a third offset value at the retrieved offset value.

As described above, also in the current offset value calculation processing, the amplitude values at the previous

second and third offset values have a very high possibility

of being smaller than the amplitude value at the previous

optimum offset value by a predetermined value or more, but

the amplitude values fail to be smaller than the value by a

5   predetermined value or more as the case may be. In such a

case, when the quadratic curve is determined with reference

to the previous optimum offset value and the previous second

and third offset values, the quadratic curve has a low

accuracy, thereby impairing the accuracy of the optimum

10   offset value corresponding to the peak of the quadratic curve.

   According to the specific construction described, when

the amplitude value at the previous second offset value is

not found to be smaller than the amplitude value at the

previous optimum offset value by a predetermined value or

15   more, retrieved is an offset value having an amplitude value

smaller than the amplitude value at the previous optimum

offset value by a predetermined value or more, to determine a

quadratic curve by setting a second offset value at the

retrieved offset value. Furthermore, when the amplitude

20   value at the previous third offset value is not found to be

smaller than the amplitude value at the previous optimum

offset value by a predetermined value or more, retrieved is

an offset value having an amplitude value smaller than the

amplitude value at the previous optimum offset value by a

predetermined value or more, to determine a quadratic curve

by setting a third offset value at the retrieved offset value.

Accordingly, the quadratic curve can be determined with high

accuracy, to thereby obtain the optimum offset value with

5   high accuracy at all times.

Stated further specifically, the disk playback device

comprises temperature detection means for detecting a

temperature of the disk. The calculation processing circuit

calculates the optimum offset value every time the disk is

10 varied in temperature by a predetermined temperature value.

According to the specific construction described, every

time the disk is varied in temperature by a predetermined

temperature value, the optimum offset value is obtained.

Based on the optimum offset value obtained, an offset

15 adjustment is made. This reproduces an error signal given

the optimum offset adjustment in accordance with temperature

variations, whereby focusing of the optical head or tracking

is controlled with high accuracy based on the error signal.

As described above, with the disk playback device of the

20 present invention, the optimum value of offset for the error

signals can be obtained in a short period of time when the

device is in the usual operation.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram showing a construction of a disk recording-playback device according to the present invention;

FIG. 2 is a flow chart showing a procedure to be
5   executed when the disk recording-playback device is initiated into operation;

FIG. 3 is a flow chart showing a first part of a specific procedure of focus offset adjustment processing to be executed when the device is initiated into operation;

10   FIG. 4 is a flow chart showing a second part of the procedure;

FIG. 5 is a flow chart showing a third part of the procedure;

FIG. 6 is a flow chart showing a procedure to be
15   executed when the disk recording-playback device is in a usual operation;

FIG. 7 is a flow chart showing a first part of a specific procedure of focus offset adjustment processing to be executed when the device is in the usual operation;

20   FIG. 8 is a flow chart showing a second part of the procedure;

FIG. 9 is a flow chart showing a third part of the procedure;

FIG. 10 is a graph illustrating the procedure of focus

offset adjustment processing to be executed when the device is initiated into operation;

FIG. 11 is a graph illustrating a procedure of offset adjustment processing to be executed when the device is in the usual operation;

FIG. 12 is an enlarged perspective view showing lands and grooves formed on a magneto-optical disk;

FIG. 13 is a flow chart showing a first part of a specific procedure of focus offset adjustment processing to be executed when a conventional disk recording-playback device is initiated into operation;

FIG. 14 is a flow chart showing a second part of the procedure;

FIG. 15 is a flow chart showing a third part of the procedure;

FIG. 16 is a flow chart showing a first part of a specific procedure of focus offset adjustment processing to be executed when the disk recording-playback device is in a usual operation;

FIG. 17 is a flow chart showing a second part of the procedure;

FIG. 18 is a flow chart showing a third part of the procedure;

FIG. 19 is a graph illustrating a procedure of focus

offset adjustment processing to be executed when the device

is initiated into operation;

FIG. 20 is a graph illustrating a procedure of focus

offset adjustment processing to be executed when the device

5   is in the usual operation.

BEST MODE OF CARRYING OUT THE INVENTION

With reference to the drawings, a detailed description

will be given below of the present invention as embodied into

10   disk recording-playback devices for use with magneto-optical

disks serving as recording media.

FIG. 1 shows a disk recording-playback device embodying

the invention and comprising a spindle motor 2 for rotatingly

driving a magneto-optical disk 1, a magnetic head 3 and an

15   optical head 5 provided above and below the magneto-optical

disk 1, respectively. A magnetic head drive circuit 4 is

connected to the magnetic head 3 while a laser drive circuit

6 is connected to the optical head 5. Connected to the

magnetic head drive circuit 4 and the laser drive circuit 6

20   is a control circuit 7, which controls recording/reproduction

operations of signals. An output signal of the optical head

5 is fed to the control circuit 7, and output to a subsequent

circuit as reproduced data after processing such as

amplification, detection of reproduction signals, and error

correction.

Further, a servo circuit 9 is connected to the spindle motor 2 and the optical head 5. An FE signal and a TE signal obtained from the output signal of the optical head 5 are fed to the servo circuit 9 from the control circuit 7. In response to the FE signal and TE signal, focus servo and tracking servo for an actuator (not shown) provided for the optical head 5 are executed. Furthermore, an external synchronizing signal is fed to the servo circuit 9 from the control circuit 7, and the rotation of the spindle motor 2 is controlled based on the signal.

Furthermore, provided opposed to the magneto-optical disk 1 is a temperature sensor 8 for measuring a temperature of the magneto-optical disk 1. An output terminal of the temperature sensor 8 is connected to the control circuit 7, where, based on temperature data obtained from the temperature sensor 8, an offset adjustment procedure as will be described below is executed, determining optimum offset values respectively for the FE signal and the TE signal, making the offset adjustment for the FE signal and the TE signal with reference to the respective optimum offset values. The FE signal and the TE signal given the offset adjustment are input to the servo circuit 9, and are fed to focus servo and tracking servo.

FIG. 2 shows a procedure to be executed by the control circuit 7 in an initiation into operation of the disk recording-playback device. When the device is turned on, first in step S1 various gains of the servo circuit 9 are set

5 at initial values. In step S2 an offset value for focus is adjusted based on the TE signal.

Next in step S3 an offset value for tracking is adjusted based on the TE signal, and thereafter in step S4 each of a recording power and reproduction power is set at an initial

10 value. Then in step S5 a gain necessary for reading out address information recorded on the magneto-optical disk (address gain) and a gain necessary for reading out an FCM (fine clock mark) (FCM gain) are set at initial values.

Subsequently in step S6 the offset value for focus is

15 adjusted based on the RF signal, and thereafter in step S7 the reproduction power is adjusted. Then in step S8 a servo gain for focus and a servo gain for tracking are adjusted, and thereafter in step S9 the address gain and FCM gain are adjusted. A series of the adjustment processing of step S6

20 to step S9 is executed for each of the lands and grooves of the test tracks pre-provided on the magneto-optical disk.

Then in step S10 the recording power is adjusted for each of the lands and grooves of the test tracks. In step S11 current values of parameters adjusted as described are

checked. Lastly in step S12 the current values of those
parameters are stored in a built-in memory, and thereafter in
step S13 a current disk temperature T_0 is stored in the
built-in memory to terminate the procedure.

5   In the focus offset adjustment processing of step S2 and
step S6 described, as seen in FIG. 10, focus offset values
are respectively set at at least five different values P_0 to
P_4 centered about an initial value P_0, and amplitude values of
the TE signal or the RF signal at the respective offset

10 values are measured. Among said at least five points
measured, a first point is set at a point having the maximum
amplitude value, a second point is set at a point having an
offset value smaller than the offset value P_0 at the first
point and an amplitude value not greater than a value (T_0 –

15 5) obtained by subtracting a predetermined value from an
amplitude value T_0 at the first point, a third point is set
at a point having an offset value greater than the offset
value P_0 at the first point and an amplitude value not
greater than the value (T_0 – 5) obtained by subtracting the

20 predetermined value from the amplitude value T_0 at the first
point. With reference to the offset values P_0, P_1, P_4 and the
amplitude values T_0, T_1, T_4 at the respective three points, a
quadratic curve representing the relationship between the
offset values and the amplitude values is determined. An

offset value corresponding to the peak of the quadratic curve is determined as an optimum offset value P_{opt1}. This procedure is the same as an offset adjustment processing to be executed when a conventional disk recording-playback device is

5   initiated into operation.

FIGS. 3 to 5 show a specific procedure of the offset adjustment processing to be executed in step S2 described. A procedure of step S21 in FIG. 3 to step S43 in FIG. 5 is the same as the conventional procedure shown in FIGS. 13 to 15.

10   In the case where the second point and the third point are included in four measured points other than the first point from among the five points measured, with reference to data on the first to third points (P_{max}, T_{max}), (P_A, T_A) and (P_B, T_B) which are included in the five points measured, the

15   relationship between the offset values and the amplitude values is approximated to a quadratic curve, calculating an offset value corresponding to the peak of the quadratic curve as an optimum offset value P_{opt} in step S43 in FIG. 5.

On the other hand, when the second point is not included

20   in the four measured points other than the first point, the second point is retrieved in steps S30 to S35 in FIG. 4. Data on the second point (P_A, T_A) retrieved is used when the relationship between the offset values and the amplitude values is approximated to a quadratic curve in step S43 in

FIG. 5.

Furthermore, when the third point is not included in the four measured points other than the first point, the third point is retrieved in steps S37 to S42 in FIG. 5. Data on

5   the third point (P_B, T_B) retrieved is used when the relationship between the offset values and the amplitude values is approximated to a quadratic curve in step S43.

In step S43 the optimum offset value is determined as described, thereafter followed by step S44 wherein the offset

10   value P_A at the second point and the offset value P_B at the third point are stored in a built-in memory, to terminate the procedure.

Accordingly, the optimum offset value P_{opt} for the focus error is determined based on the TE signal, and the focus

15   offset adjustment is made with reference to the optimum offset value P_{opt}. Further, in the offset adjustment processing to be executed in step S6 in FIG. 2, which is the same as the processing shown in FIGS. 3 to 5, an optimum offset value for the focus error is determined based on the

20   RF signal, and a focus offset adjustment is made based on the optimum offset value.

With the disk recording-playback device described, the focus offset adjustment is made based on the TE signal, as described, while the focus offset adjustment is made based on

the RF signal, and signal reproduction and signal recording are thereafter started.

FIG. 6 shows a procedure to be executed by the control circuit 7 in a usual operation for signal reproduction and signal recording after the system's initiation into operation. When the usual operation is started, first in step S51 a past disk temperature T_{old} is set at a temperature T_0 stored in the built-in memory in the initiation into operation of the device as described. In step S52 after the elapse of a predetermined period of time, a current disk temperature T_{now} is measured.

Subsequently in step S53 an inquiry is made as to whether the current disk temperature T_{now} is not less than a temperature (T_{old} + T_{thr}) obtained by adding the past disk temperature T_{old} to a predetermined temperature T_{thr}. When the answer is negative, the sequence returns to step S52 to repeat the same procedure. Here, the predetermined temperature T_{thr} is set at 5 °C, for example.

When variations of the disk temperature in excess of or equal to the predetermined temperature T_{thr} make the answer for step S53 affirmative, the sequence proceeds to step S54 wherein an inquiry is made as to whether the device is set capable of adjusting various parameters in accordance with temperature variations of the disk. When the answer for step

S54 is negative, the sequence returns to step S52. On the other hand, when the answer is affirmative, step S55 follows to adjust the reproduction power, and thereafter in step S56 the recording power is adjusted.

5   Then in step S57 the focus offset value is adjusted based on the RF signal, and thereafter in step S58 the focus offset value is adjusted based on the TE signal. Lastly in step S59 current values of parameters adjusted as described are stored in the built-in memory, and thereafter in step S60

10   the past disk temperature T_{old} is set at the current disk temperature T_{now}. Then the sequence returns to step S52. According to the procedure described, every time variations in temperature of the disk in excess of or equal to a predetermined temperature occur, the focus offset adjustment

15   processing is repeated.

       In the previous offset adjustment processing, for example, as seen in FIG. 10, the second and third offset values P_1, P_4 each has an amplitude value smaller than the amplitude value T_0 at the first offset value P_0 by a

20   predetermined value or more. Further, the optimum offset value T_{opt1} has an amplitude value greater than the amplitude value T_0 at the first offset value P_0. Thus the second and third offset values P_1, P_4 each has an amplitude value smaller than an amplitude value T_{opt1} at the optimum offset value P_{opt1}

by a predetermined value or more.

Furthermore, when the disk recording-playback device is in the usual reproduction operation, there is little change in the quadratic curve representing the relationship between the offset values and the amplitude values. Accordingly, also in the current offset adjustment processing, amplitude values T_1, T_4 at the second and third offset values P_1, P_4 obtained in the previous offset adjustment processing have a very high possibility of being smaller than the amplitude value T_{opt1} at the previous optimum offset value P_{opt1} by a predetermined value or more, as seen in FIG. 11.

In the focus offset adjustment processing in step S57 and step S58 shown in FIG. 6, focus offset values are respectively set at the optimum offset value P_{opt1} determined in the previous offset adjustment processing, i.e., the set value concerned, and the previous second offset value P_1 and the previous third offset value P_4, as seen in FIG. 11, and amplitude values at the respective offset values for the TE signal or the RF signal are measured. When the second offset value P_1 and the third offset value P_4 each has an amplitude value not greater than a value (T_{opt1} - 5) obtained by subtracting a predetermined value from the optimum offset value P_{opt1}, a quadratic curve representing the relationship between the offset values and the amplitude values is

determined with reference to the offset values P_{opt1}, P_1, P_4

and the amplitude values T_{opt1}, T_1, T_4 at the respective three

measured point. An offset value corresponding to the peak of

the quadratic curve is determined as an optimum offset value

5   P_{opt2}.

FIGS. 7 to 9 show a specific procedure of the focus

offset adjustment processing to be executed in step S57

described. First in step S61 in FIG. 7, set to "FALSE" are a

P_A_flag and a P_B_flag indicating whether the second and third

10   offset values P_A, P_B are each obtained. In step S62, a focus

offset value is set at a set value P_0' concerned, i.e., the

previous optimum offset value, and an amplitude value T_0' for

an RF signal is measured.

Subsequently in step S63, a first offset value P_{max}' is

15   set at the set value P_0', and a first amplitude value T_{max}' is

set at the measured amplitude value T_0'. In step S64, offset

values are respectively set at the two values P_A, P_B stored in

the built-in memory, i.e., the second offset and the third

offset value used when the quadratic curve is determined in

20   the previous offset adjustment processing, and amplitude

values T_A, T_B at the respective offset values are measured.

Next in step S65, an inquiry is made as to whether the

measured amplitude value T_A is smaller than the first

amplitude value T_{max}' by five steps or more. If the inquiry

is answered in the affirmative, step S66 follows to set to "TRUE" the P_A_flag indicating whether the second offset value is obtained, and thereafter followed by step S67.

In step S67, an inquiry is made as to whether the

5 measured amplitude value T_B is smaller than the first amplitude value T_{max}' by five steps or more. If the inquiry is answered in the affirmative, step S68 follows to set to "TRUE" the P_B_flag indicating whether the third offset value is obtained, and thereafter followed by step S69 in FIG. 8.

10 When the amplitude values T_A, T_B at the previous second offset value P_A and the third offset value P_B are both smaller than the first amplitude value T_{max}' by five steps or more, inquiries in step S69 in FIG. 8 and in step S76 in FIG. 9 are answered in the affirmative. Then step S83 follows wherein

15 the relationship between the offset values and the amplitude values is approximated to a quadratic curve with reference to the data on the three measured points (P_{max}', T_{max}'), (P_A, T_A) and (P_B, T_B), and an offset value corresponding to the peak of the quadratic curve is calculated to be an optimum offset

20 value P_{opt}. Lastly in step S84, the second offset value P_A and the third offset value P_B are stored in the built-in memory, to terminate the procedure. Accordingly, a new optimum offset value P_{opt} is obtained with reference to the optimum offset value and the second and third offset values which are

obtained in the previous offset adjustment processing, and the amplitude values at the respective offset values.

On the other hand, when the amplitude value T_A at the previous second offset value P_A is not smaller than the first amplitude value T_{max}' by five steps or more, an inquiry in step S69 in FIG. 8 is answered in the negative. In steps S70 to S75, an offset value is decreased starting from a value smaller than the offset value P_A by four steps, to thereby vary the offset value until when an amplitude value T becomes a value smaller than the first amplitude value T_{max}' by five steps or more. Then a second offset value P_A and a second amplitude value T_A are respectively set at the offset value and the amplitude value concerned. The second point is thus retrieved. Thereafter in step S83 in FIG. 9, when the relationship between the offset values and the amplitude values is approximated to a quadratic curve, the retrieved data (P_A, T_A) on the second point is referred to. However, when an offset value becomes a value smaller than the previous optimum offset value by 20 steps or more to make the answer in step S71 affirmative, and when an amplitude value T is not greater than a lower limit value T_L to make the answer in step S73 affirmative, focus servo deviates, to thereby terminate the procedure.

Furthermore, when the amplitude value T_B at the previous

third offset value P_B is not smaller than the first amplitude

value T_{max}' by five steps or more, an inquiry in step S76 in

FIG. 9 is answered in the negative. In steps S77 to S82, an

offset value is increased starting from a value greater than

5   the offset value P_B by four steps, to thereby vary the offset

value until when the amplitude value T becomes a value

smaller than the first amplitude value T_{max}' by five steps or

more. Then a third offset value P_B and a third amplitude

value T_B are respectively set at the offset value and the

10   amplitude value concerned. The third point is thus retrieved.

Thereafter in step S83, when the relationship between the

offset values and the amplitude values is approximated to a

quadratic curve, the retrieved data (P_B, T_B) on the third

point is referred to. However, when an offset value becomes

15   a value greater than the previous optimum offset value by 20

steps or more to make the answer in step S78 affirmative, and

when an amplitude value is not greater than a lower limit

value T_L to make the answer in step S80 affirmative, focus

servo deviates, to thereby terminate the procedure.

20   Accordingly, the optimum offset value P_{opt} for the focus

error is obtained based on the RF signals, to thereby make a

focus offset adjustment based on the optimum offset value.

Furthermore, in the offset adjustment processing to be

executed in step S58 in FIG. 6, the optimum offset value for

the focus error is obtained based on the TF signals according to the same procedure as that in FIGS. 7 to 9, to thereby make a focus offset adjustment based on the offset value. Consequently, focus servo is effected with high accuracy at

5   all times despite variations in temperature of the magneto-optical disk.

In the focus offset adjustment processing to be executed in the usual operation of the disk recording-playback device embodying the present invention, the amplitude values each at

10 the previous offset value P_{opt1}, the previous second offset value P_1, and the previous third offset value P_4 is measured, as seen in FIG. 11. When the amplitude values at the second and third offset values P_1, P_4 are both smaller than the amplitude value at the optimum offset value P_{opt1} by five

15 steps or more, the quadratic curve representing the relationship between the offset values and the amplitude values is determined with reference to the offset values and the amplitude values at the three measured points. This makes a period of time required for the determination of the

20 quadratic curve shorter than conventionally, because, with the conventional disk recording-playback device, the amplitude values need be measured at at least five points. Consequently, a period of time taken for deriving the optimum offset value is reduced.

Furthermore, when the amplitude value at the previous second offset value fails to be a value smaller than the amplitude value at the previous optimum offset value by five steps or more, a new offset value is retrieved wherein an

5   amplitude value is a value smaller than the amplitude value at the previous optimum offset value by five steps or more, as shown in FIG. 8. Further, when the amplitude value at the previous third offset value fails to be a value smaller than the amplitude value at the previous optimum offset value by

10   five steps or more, a new offset value is retrieved wherein an amplitude value is a value smaller than the amplitude value at the previous optimum offset value by five steps or more, as shown in FIG. 9. Thereafter, a quadratic curve is determined with reference to the offset value thus retrieved.

15   Accordingly, the quadratic curve is determined with high accuracy constantly, to thereby obtain the optimum offset value with high accuracy at all times.

The present invention is not limited to the foregoing embodiment in construction but can be modified variously

20   within the technical scope defined in the appended claims.

For example, in the usual operation, tracking offset adjustment processing can be performed. In this case the optimum offset value can be obtained in accordance with the procedure shown in FIG. 11.